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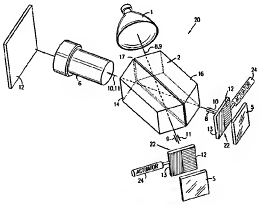
(54) Title: SEQUENTIAL IMAGING SYSTEM



(57) Abstract: This invention discloses a sequential imaging system, which includes a light source, a polarizing beam splitter operative to split the light impinging thereon from the light source into two polarized beams, two color filter elements through which the polarized beams pass, one of the color filter elements being divided into two divisions, each division including a different color filter, and the other color filter element including at least one color filter, for each polarized beam, a spatial light modulator adapted to receive the polarized beam which passes through one of the color filter elements and operable to generate an image using the beam, each image being a subframe of an image frame, each of the images being reflected from the spatial light modulator back to the polarizing beam splitter which is operable to combine the images, and a controller operable to control the light source, the color filter elements, and the spatial light modulators such that the images are sequentially projected one after another to form the image frame, wherein at least one image from one of the spatial light modulators containing a first color is projected substantially simultaneously with at least one image from the other spatial light modulator containing a second color different from the first color. A method for sequential imaging is also disclosed.

WO 01/37576 A1

SEQUENTIAL IMAGING SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to imaging systems, and more particularly to a method and apparatus for reduction or elimination of color separation in sequential color imaging.

BACKGROUND OF THE INVENTION

Color projection systems are used in many applications, including conventional television (whether in NTSC, PAL, SECAM, or other formats), wide scene conventional television, high definition television, industrial projectors, home use projectors, and cinema projectors, among other applications. Color projection systems strive to project color images on a screen with a high image quality, while at the same time maintaining low cost and low complexity. Several systems exist in the prior art for achieving these goals, each with their advantages and disadvantages.

One type of basic system employs a single LCD that integrally includes color filters as subpixels (generally red, green, blue - RGB). Advantages are very low cost and complexity. A disadvantage is that since the LCD employs three subpixels (RGB) in order to achieve the color output of one pixel, it is difficult or costly to achieve high resolution. Another disadvantage is that 2/3 of the light impinging on the LCD is wasted.

Another system, called a non-sequential color system, divides the color input into three basic color inputs (such as RGB) and transmits them to three individual monochromatic LCDs at high resolution. A projector lens projects the three monochromatic images from the LCDs onto a screen. An advantage of this system is that basically all of the light is utilized. A disadvantage is that the system is complex, since three LCDs are required instead of one. Moreover, the three images must be aligned with a high degree of accuracy, which increases the cost of the projection system.

Another class of imaging systems, known as sequential color systems, offer lower cost and complexity than other imaging systems, but at the sacrifice of some image quality. Sequential color systems transmit light which has been filtered in time into three basic color inputs (such as RGB) onto a single LCD at speeds much greater than the above described systems. The result is a sequence of three differently colored,

monochromatic images which are rapidly projected one after the other. The human eye superimposes the three monochromatic images and perceives a full color image nearly like the original. For example, typical sequential color systems generate images by sequentially laying down red, green, and blue light in a single image frame, which typically lasts 1/60 of a second. In non-sequential color systems, the red, green, and blue light are laid down simultaneously. The nonsequential color systems, therefore, employ about three times the hardware and complexity of sequential color systems.

Liquid crystal displays are just one example of a spatial light modulator (SLM) used in color projection systems. Another type of SLM imaging system employs arrays of individual elements, such as digital mirror devices (DMDs), to reflect light onto or away from a projection screen. In non-sequential color systems, three DMD arrays are used in parallel, one each for red, green, and blue light. In contrast, a sequential color system SLM device requires only one such array, with the red, green, and blue light sequentially reflected by the single DMD array. The need for three such arrays in the non-sequential color system triples the requirements for the DMD arrays and attendant hardware over the sequential color system.

However, sequential color systems have certain limitations. One such limitation is that of color separation. Color separation occurs in sequential color systems when an imaged object moves across a projection screen with respect to the human eye. This means that color separation can occur when:

a. the object moves across a screen and the viewer is stationary

b. the viewer moves while the object is stationary

Color separation can be simply explained by the following example. Suppose a color image of an airplane moves across a projection screen. For a sequential color system that lays down color in the order of red, green, and then blue, the airplane will be generated by first laying down the red, then the green, and then the blue. Therefore, as the airplane moves, the front extremity of its leading edge (nose) will appear red, the neighboring region (in the direction of the tail) will be a combination of red and green, and then finally the proper combination of red, green and blue will appear. At the trailing edge (tail), the opposite is true: the rear extremity will appear blue, the neighboring

region (in the direction of the nose) will be a combination of blue and green, and then finally the proper combination of red, green and blue will appear.

Prior art sequential color systems that attempt to reduce or eliminate color separation are known. An example of such a sequential color system is US Patent 5,448,314 to Heimbuch et al., the disclosure of which is incorporated herein by reference. In this system, images are generated by illuminating light from a light source through a color wheel onto a DMD array. Light from the DMD array is projected on a screen. By adjusting the speed and make-up of color wheel, color separation is greatly reduced or eliminated.

In one method of the Heimbuch et al. patent, a processor is provided which controls the light source, the color wheel, and the DMD array such that at least two color subframes of a first color, at least one color subframe of a second color, and at least one color subframe of a third color are generated during one image frame. For example, instead of projecting RGB, the system projects RGBG. This is particularly effective because of the fact that red, green, and blue light carry different perceptual weightings. In general, it is believed that the human eye perceives green light better than it perceives red light, and blue light is perceived worst. Tests have shown that green light is perceived about five times better than blue light, and green light is perceived almost twice as well as red light. Thus, better color mixing is achieved by splitting the green light into two color subframes.

In another method, a color subframe of a first color, a color subframe of a second color, and a color subframe of a third color are generated in one image frame (e.g., RGB). During the next image frame, the order that the color subframes are generated is reversed (e.g., BGR). This alternating sequence for each image frame results in the leading edge of the moving object flickering from red to blue and blue to red at a rate of half the image frame frequency, for example, a flicker of 30 Hz for an image frame frequency of 60 Hz. The trailing edge of the moving object will have the same flicker. This flicker may be perceived as a flicker or as a combination of red and blue, for example, magenta. The result is a perception that the leading edge and trailing edge of the moving object are closer to the true color than in conventional systems. Furthermore,

as the moving object changes direction, the leading and trailing edges will not "switch" colors, as occurs with other prior art systems.

SUMMARY OF THE INVENTION

The present invention seeks to provide improved methods and apparatus for reduction or elimination of color separation in sequential color imaging.

In the present invention light is split into two differently polarized beams which pass through two color filter elements. Each color filter element is preferably divided into two divisions of different colors, or alternatively, one of the divisions passing white light. Each polarized beam passes through the color filter element to a spatial light modulator, preferably a reflecting SLM. The polarized beam impinges on a pixel of the SLM which generates an image, the image being a subframe of a complete image frame.

The images are reflected back from the LCDs and combined for projection onto a screen. The images are sequentially projected one after another to form the complete image frame. One image (or more than one image) from one of the LCDs contains a first color and is projected substantially simultaneously with one image (or more than one image) from the other LCD containing a second color different from the first color.

Thus, an important advantage of the present invention is that *two* images containing two colors are constantly projected on a screen, or alternatively two images of white light and one color. This is in contrast to the prior art wherein only *one* image is projected at a time. For example, as mentioned above, in US Patent 5,448,314 to Heimbuch et al., several subframes, such as RGBG, are generated during one image frame. However, at all times only one image (subframe) is projected at a time. The constant projection of two images simultaneously, unique to the present invention, improves the reduction of color separation, because the trailing and leading edges of an image will not be made up of a single color but rather two colors. It is readily appreciated that one color separating from the rest of the image stands out more to the eye than a combination of two colors.

There is thus provided in accordance with a preferred embodiment of the present invention a sequential imaging system, including a light source, a polarizing beam splitter operative to split the light impinging thereon from the light source into two polarized beams, two color filter elements through which the polarized beams pass, one of the

color filter elements being divided into two divisions, each division including a different color filter, and the other color filter element comprising at least one color filter, and for each polarized beam, a spatial light modulator adapted to receive the polarized beam which passes through one of the color filter elements and operable to generate an image using the beam, each image being a subframe of an image frame, each of the images being reflected from the spatial light modulator back to the polarizing beam splitter which is operable to combine the images, and a controller operable to control the light source, the color filter elements, and the spatial light modulators such that the images are sequentially projected one after another to form the image frame, wherein at least one image from one of the spatial light modulators containing a first color is projected substantially simultaneously with at least one image from the other spatial light modulator containing a second color different from the first color.

In accordance with a preferred embodiment of the present invention the polarizing beam splitter is operative to split the light impinging thereon from the light source into two differently polarized beams.

Further in accordance with a preferred embodiment of the present invention the first and second colors are part of a three primary additive color system.

Still further in accordance with a preferred embodiment of the present invention one of the divisions of the color filter elements passes white light therethrough, and one of the first and second colors is the white light.

Additionally in accordance with a preferred embodiment of the present invention the controller is operative to cause a phase shift between movement of the color filter elements, such that one of the polarized beams passes through both divisions of one of the color filter elements, and the image associated with that polarized beam contains two colors, and that image containing two colors is projected substantially simultaneously with at least one image from the other spatial light modulator containing at least one color. Preferably one of the two colors is different from the at least one color. Alternatively, both of the two colors are different from the at least one color.

In accordance with a preferred embodiment of the present invention the color filter element is generally circular. Alternatively, the color filter element may include a polygonal color filter element.

Further in accordance with a preferred embodiment of the present invention an actuator moves the color filter elements. The actuator may move the color filter element in a direction generally parallel to a plane of its corresponding spatial light modulator, for example. The actuator may move the color filter element generally linearly, arcuately or in a swinging motion.

Still further in accordance with a preferred embodiment of the present invention the divisions of the color filter elements have polygonal shapes. Alternatively, the divisions of the color filter elements may have an irregular shape.

In accordance with a preferred embodiment of the present invention the divisions of the color filter elements are separated by a non-transmissive stripe.

Further in accordance with a preferred embodiment of the present invention the spatial light modulators include reflective LCDs.

There is also provided in accordance with a preferred embodiment of the present invention a method for sequential imaging, including splitting light into two polarized beams, passing the polarized beams through two color filter elements, each color filter element being divided into two divisions, each division including a different color filter, for each polarized beam, using a spatial light modulator to receive the polarized beam and to generate an image using the beam, each image being a subframe of an image frame, reflecting each of the images from the spatial light modulator and combining the images for projection onto a screen, and sequentially projecting the images one after another to form the image frame, wherein at least one image from one of the spatial light modulators containing a first color is projected substantially simultaneously with at least one image from the other spatial light modulator containing a second color different from the first color.

In accordance with a preferred embodiment of the present invention the light is split into two differently polarized beams.

Further in accordance with a preferred embodiment of the present invention the method includes transmitting an initial image to the spatial light modulator for an initial color, passing the polarized beam through one of the divisions of one of the color filter elements, the beam being projected on the spatial light modulator, moving the color filter element such that the polarized beam passes through a line of demarcation between the

divisions of that color filter element, detecting that the line of demarcation between the divisions is projected onto the spatial light modulator, and sending a subsequent image to the spatial light modulator for a subsequent color, without removing the initial color, such that the subsequent color overrides the initial image.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

Fig. 1 is a simplified pictorial illustration of a projection system constructed and operative in accordance with a preferred embodiment of the present invention;

Fig. 2 is a simplified pictorial illustration of a projection system constructed and operative in accordance with another preferred embodiment of the present invention;

Fig. 3 is a simplified pictorial illustration of a projection system constructed and operative in accordance with yet another preferred embodiment of the present invention; and

Figs. 4A-4F are simplified pictorial illustrations of color filter elements useful in the projection systems of Figs. 1-3, constructed and operative in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference is now made to Fig. 1 which illustrates a projection system 20 constructed and operative in accordance with a preferred embodiment of the present invention. Projector system 20 preferably includes a light source 1, such as an arc lamp based illuminator, which directs a beam of light onto a polarizing beam splitter/combiner 2.

Polarizing beam splitter/combiner 2 (also herein referred to as polarizing beam splitter 2) is preferably constructed as described in applicant/assignee's US Patent 5,946,139 and PCT published patent application WO 99/52269, the disclosures of which are incorporated herein by reference. Polarizing beam splitter 2 preferably comprises first and second prisms 14 and 16 separated by a birefringent material 17. Alternatively, polarizing beam splitter 2 may comprise Glen-Thompson or Wollaston prisms which are commercially available from Melles Griot or Spindler & Hoyer. As a further alternative,

polarizing beam splitter 2 may be a conventional broad-band polarizing beam splitter comprising plural prisms which are separated by multilayer optical coatings.

Polarizing beam splitter 2 is operative to split the light impinging thereon from light source 1 into two polarized beams, 8 and 9. Beams 8 and 9 typically, but not necessarily, have different polarizations, such as the p and s components of polarized light, respectively. Beam 8 is reflected in the area of the interface of prisms 14 and 16 towards a first color filter element, herein referred to as color wheel 3. Beam 9 passes unreflected to a second color filter element, herein referred to as color wheel 4. After passing through the color wheels, beams 8 and 9 each impinge on a selectably actuable polarization-rotating light valve 5 operating in a reflective mode. An example of a suitable light valve is a conventional reflective LCD without a polarizer. Light valve 5 is herein referred to as LCD 5.

Beams 8 and 9 are reflected from LCDs 5 as reflected beams 10 and 11. If beams 8 and 9 each impinge upon a pixel in the corresponding LCD 5 which changes the polarity of the beam, then beams 10 and 11 have a different polarity than that of beams 8 and 9, such as s and p, respectively. Reflected beam 10 passes through color wheel 3, and since it has p polarity, it passes unreflected through polarizing beam splitter 2 and is projected onto a screen 12 by means of a lens 6. Reflected beam 11 passes through color wheel 4, and since it has s polarity, it is reflected in the area of the interface of prisms 14 and 16, and is also projected onto screen 12 by means of lens 6. Thus polarizing beam splitter 2 increases utilization of the light from light source 1 and increases the brightness of the image projected onto screen 12.

It is noted that color wheels 3 and 4 are not part of the illumination system of light source 1, but rather are placed between polarizing beam splitter 2 and LCDs 5. Screen 12 may be any projection surface, such as a projector screen, a television screen, a printer drum, a piece of photographic film, or any photosensitive media, for example.

As seen in Fig. 1, in accordance with a preferred embodiment of the present invention color wheels 3 and 4 are each divided into two divisions 3A, 3B and 4A, 4B, respectively, each division including a different color filter. The two colors may be part of a three primary additive color system, such as red, green and blue (RGB). In such a case, the two colors may be R and G or G and B or R and B. Alternatively, one of the

color filter elements may be divided into two divisions, and the other color filter element can include just one, or more than one, color filter.

As seen in Fig. 2, in accordance with another preferred embodiment of the present invention one color wheel 3' may have one division 3C with a green color filter, and another division 3D may have no color filter, meaning that division 3D passes white light. Another color wheel 4' may have one division 4C with a red color filter, and another division 4D with a blue filter. By selectively blending the light directed from region division 3D allocated to white light, with light directed from the other regions, the overall brightness of the image projected on screen 12 is increased.

It is noted that similar use of white light is described in US Patent 5,233,385 to Sampsell, the disclosure of which is incorporated herein by reference. However, Sampsell requires *four* regions in the color wheel, three dedicated to light of one of three primary additive colors (RGB), and the other region being dedicated to white light. In the present invention, only *two* regions are used in each color wheel.

An important advantage of the present invention is that *two* images containing two colors are constantly projected on screen 12 (as in Fig. 1), or alternatively two images of white light and one color (as in Fig. 2). This is in contrast to the prior art wherein only *one* image is projected at a time. For example, as mentioned above, in US Patent 5,448,314 to Heimbuch et al., several subframes, such as RGBG, are generated during one image frame. However, at all times only one image (subframe) is projected at a time. The constant projection of two images simultaneously, unique to the present invention, improves the reduction of color separation, because the trailing and leading edges of an image will not be made up of a single color but rather two colors. It is readily appreciated that one color separating from the rest of the image stands out more to the eye than a combination of two colors.

Projection system 20 preferably includes control electronics, herein referred to as a controller 21, that feeds the images (subframes) to be projected to LCDs 5. Controller 21 is in electrical communication with LCDs 5 and color wheels 3 and 4 (or 3' and 4'). Controller 21 preferably feeds separate images to each LCD 5 in synchronization with the colored light impinging on that LCD from its corresponding color wheel 3 or 4 (or 3' or 4'). The images can be projected by laying down one color at a time separately from

each other, e.g., by changing the electronic image signal fed to the LCD per each subframe. Alternatively, two colors can be laid down simultaneously on the LCDs, as is now explained.

Controller 21 typically synchronizes the rotation of the color wheels with each other. However, in accordance with another preferred embodiment of the present invention, controller 21 may cause a phase shift of any desired magnitude between the rotations of the two color wheels 3 and 4 (as in Fig. 1) or 3' and 4' (as in Fig. 2). This phase shift means that at some times during the color wheel rotation, while one color of one color wheel is laid down on screen 12, two colors of the other color wheel will also be laid down on screen 12, thereby further reducing the phenomenon of color separation. Alternatively, the color wheels may each include more than two colors and be rotated with a phase shift therebetween.

Reference is now made to Fig. 3 which illustrates a variation of the structure shown in Fig. 1. In this embodiment, instead of generally circular color wheels, the invention preferably employs a polygonal color filter element 22, such as a generally rectangular color filter element that includes two or more color filters 12 and 13. The colors of filters 12 and 13 may be as described hereinabove with reference to the embodiments of Figs. 1 and 2. Color filter element 22 is preferably moved by an actuator 24 attached thereto. Actuator 24, which may be a step motor operating in a closed loop control system, can move color filter element 22 closer to or further from, generally perpendicularly to, LCDs 5, or can move color filter element 22 generally parallel to a plane of LCDs 5. Actuator 24 can move color filter element 22 linearly, arcuately or in a swinging motion of a pendulum, for example. Of course, actuator 24 may also be used to rotate the color wheels illustrated in Figs. 1 and 2.

Referring to Figs. 4A-4F, the color filter elements may have different kinds of configurations. For example, as seen in Fig. 4A, a color filter element 26 includes two generally rectangular regions 28 and 30, each with a different color filter, such as R and G. In Fig. 4B, a color filter element 32 includes three generally rectangular regions 34, 36 and 38, each with a different color filter, such as R, G and B. In Fig. 4C, a color filter element 40 includes three generally rectangular regions 42, 44 and 46, wherein regions

42 and 46 include the same color filter, such as R, and region 44 is colored differently, such as G.

Instead of rectangular regions, a color filter element 47 may include trapezoidal regions 48 and 50, as shown in Fig. 4D. Indeed the color filter element may be of any arbitrary shape or size, such as an irregularly shaped color filter element 52 shown in Fig. 4E.

As seen in Fig. 4F, two different regions 54 and 56 of a color filter element 58, may be separated by a non-transmissive stripe 60 which may be useful in synchronizing movement of color filter element 58, as described hereinbelow.

As mentioned above, controller 21 can lay down one color at a time separately from each other. Alternatively, two colors can be laid down simultaneously on the LCDs. In both of these cases, the color wheels or color filter elements must be typically moved rapidly during one complete image frame, in order to avoid light losses when switching from one color to another.

However, in accordance with another preferred embodiment of the present invention, the color wheels or color filter elements can be moved during one complete image frame, as is now explained. Initially, a first color is projected onto the LCD 5 from the color wheel 3 or 4 (or 3' or 4') or color filter element (22, 26, 32, 40, 47, 52 or 58). As the color wheel or color filter element is moved from one color to another, the line of demarcation between the different color regions of the color wheels or color filter elements is also projected onto the LCD. At that point, two colors are projected onto the LCD: a), the previous or "old" color, and b), the next or "new" color, plus the line of demarcation between these colors. As soon as the electronics of controller 21 detects that the line of demarcation between the colors is projected onto the LCDs, controller 21 feeds the image to the LCD solely in the "new" color, without removing or erasing the "old" color. In this manner, the image in the "new" color overrides the image in the "old" color. By employing non-transmissive stripe 60 as the line of demarcation between the colors, it is easier for the electronics of controller 21 to recognize the passing of one color to another.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope

of the present invention include both combinations and sub-combinations of the various features described hereinabove as well as variations and modifications of such features as would occur to a person skilled in the art upon reading the description and which are not in the prior art.

CLAIMS

What is claimed is:

1. A sequential imaging system, comprising:

a light source;

a polarizing beam splitter operative to split the light impinging thereon from said light source into two polarized beams;

two color filter elements through which said polarized beams pass, one of said color filter elements being divided into two divisions, each division including a different color filter, and the other color filter element comprising at least one color filter;

for each polarized beam, a spatial light modulator adapted to receive said polarized beam which passes through one of said color filter elements and operable to generate an image using said beam, each image being a subframe of an image frame, each of said images being reflected from said spatial light modulator back to said polarizing beam splitter which is operable to combine said images; and

a controller operable to control said light source, said color filter elements, and said spatial light modulators such that said images are sequentially projected one after another to form the image frame, wherein at least one image from one of said spatial light modulators containing a first color is projected substantially simultaneously with at least one image from the other spatial light modulator containing a second color different from the first color.

2. The system according to claim 1 wherein said polarizing beam splitter is operative to split the light impinging thereon from said light source into two differently polarized beams.

3. The system according to claim 1 wherein said first and second colors are part of a three primary additive color system.

4. The system according to claim 1 wherein one of said divisions of said color filter elements passes white light therethrough, and one of said first and second colors is the white light.

5. The system according to claim 1 wherein said controller is operative to cause a phase shift between movement of said color filter elements, such that one of the polarized beams passes through both divisions of one of said color filter elements, and

the image associated with that polarized beam contains two colors, and that image containing two colors is projected substantially simultaneously with at least one image from the other spatial light modulator containing at least one color.

6. The system according to claim 5 wherein one of said two colors is different from said at least one color.

7. The system according to claim 5 wherein both of said two colors are different from said at least one color.

8. The system according to any of the preceding claims wherein said color filter element is generally circular.

9. The system according to any of the preceding claims 1-7 wherein said color filter element comprises a polygonal color filter element.

10. The system according to any of the preceding claims and further comprising an actuator which moves said color filter elements.

11. The system according to claim 10 wherein said actuator moves said color filter element in a direction generally parallel to a plane of its corresponding spatial light modulator.

12. The system according to claim 10 wherein said actuator moves said color filter element generally linearly.

13. The system according to claim 10 wherein said actuator moves said color filter element generally arcuately.

14. The system according to claim 10 wherein said actuator moves said color filter element generally in a swinging motion.

15. The system according to any of the preceding claims wherein said divisions of said color filter elements have polygonal shapes.

16. The system according to any of the preceding claims 1-14 wherein said divisions of said color filter elements have an irregular shape.

17. The system according to any of the preceding claims wherein said divisions of said color filter elements are separated by a non-transmissive stripe.

18. The system according to any of the preceding claims wherein said spatial light modulators comprise reflective LCDs.

19. A method for sequential imaging, comprising:

splitting light into two polarized beams;

passing said polarized beams through two color filter elements, each color filter element being divided into two divisions, each division including a different color filter;

for each polarized beam, using a spatial light modulator to receive said polarized beam and to generate an image using said beam, each image being a subframe of an image frame;

reflecting each of said images from said spatial light modulator and combining said images for projection onto a screen; and

sequentially projecting said images one after another to form the image frame, wherein at least one image from one of said spatial light modulators containing a first color is projected substantially simultaneously with at least one image from the other spatial light modulator containing a second color different from the first color.

20. The method according to claim 19 further comprising splitting said light into two differently polarized beams.

21. The method according to claim 19 wherein said first and second colors are part of a three primary additive color system.

22. The method according to claim 19 wherein one of said divisions of said color filter elements passes white light therethrough, and one of said first and second colors is the white light.

23. The method according to claim 19 and further comprising causing a phase shift between movement of said color filter elements, such that one of the polarized beams passes through both divisions of one of said color filter elements, and the image associated with that polarized beam contains two colors, and that image containing two colors is projected substantially simultaneously with at least one image from the other spatial light modulator containing at least one color.

24. The method according to claim 23 wherein one of said two colors is different from said at least one color.

25. The method according to claim 23 wherein both of said two colors are different from said at least one color.

26. The method according to claim 19 further comprising:

transmitting an initial image to said spatial light modulator for an initial color;

passing the polarized beam through one of the divisions of one of said color filter elements, said beam being projected on said spatial light modulator;

moving said color filter element such that the polarized beam passes through a line of demarcation between the divisions of that color filter element;

detecting that the line of demarcation between the divisions is projected onto the spatial light modulator; and

sending a subsequent image to said spatial light modulator for a subsequent color, without removing said initial color, such that said subsequent color overrides the initial image.

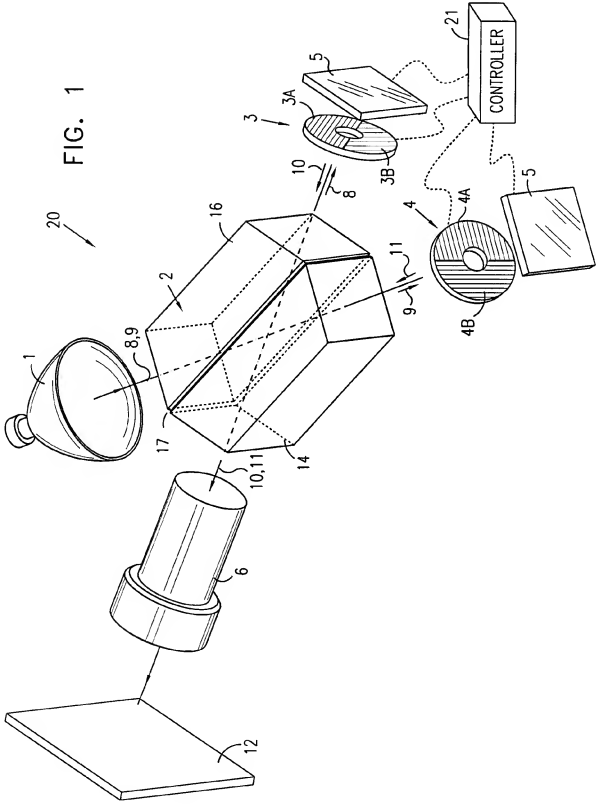


FIG. 1

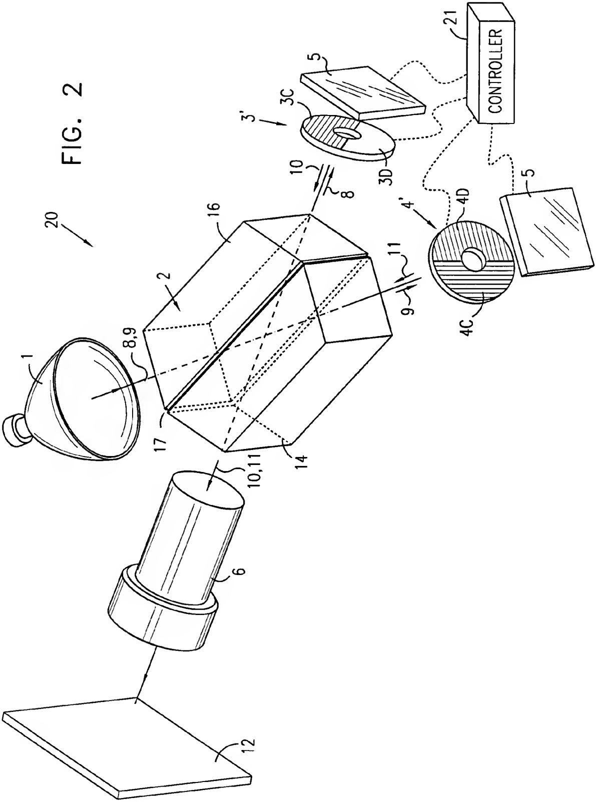
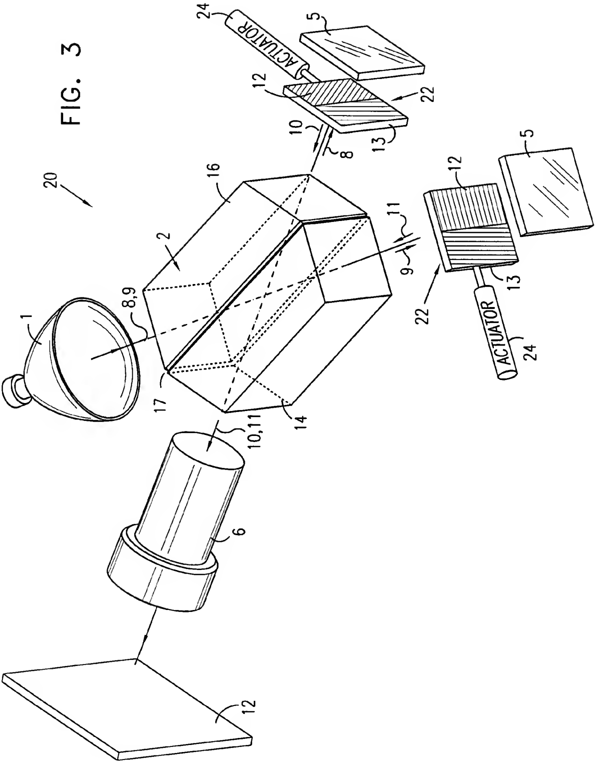


FIG. 2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8,9
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ACTUATOR
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FIG. 3

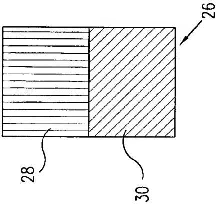

FIG. 4A

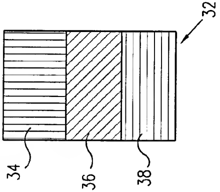

FIG. 4B

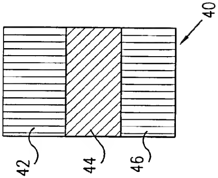

FIG. 4C

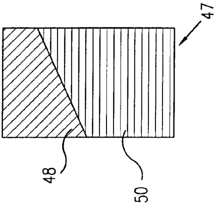

FIG. 4D

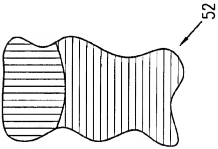

FIG. 4E

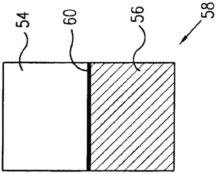

FIG. 4F

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL 00/00728

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N9/31

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 357 288 A (HIROSHIMA YASUNORI ET AL) 18 October 1994 (1994-10-18) column 9, line 7 -column 11, line 52 ---	1,19
Y	US 5 784 038 A (IRWIN DEAN) 21 July 1998 (1998-07-21) abstract; figures 5,10 ---	1,19
A	US 5 921 650 A (DOANY FUAD ELIAS ET AL) 13 July 1999 (1999-07-13) abstract; figures 3,10,13 column 7, line 34 -column 8, line 35 --- -/--	1,19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 January 2001	30/01/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Pigniez, T

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International Application No
PCT/IL 00/00728

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 07, 31 March 1998 (1998-03-31) & JP 01 149088 A (CANON INC), 12 June 1989 (1989-06-12) abstract; figures 3,7 ---	1,19
A	WO 99 52269 A (UNIC VIEW LTD ;BARAK SHLOMO (IL)) 14 October 1999 (1999-10-14) the whole document ---	1,19
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